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H04B 1/59

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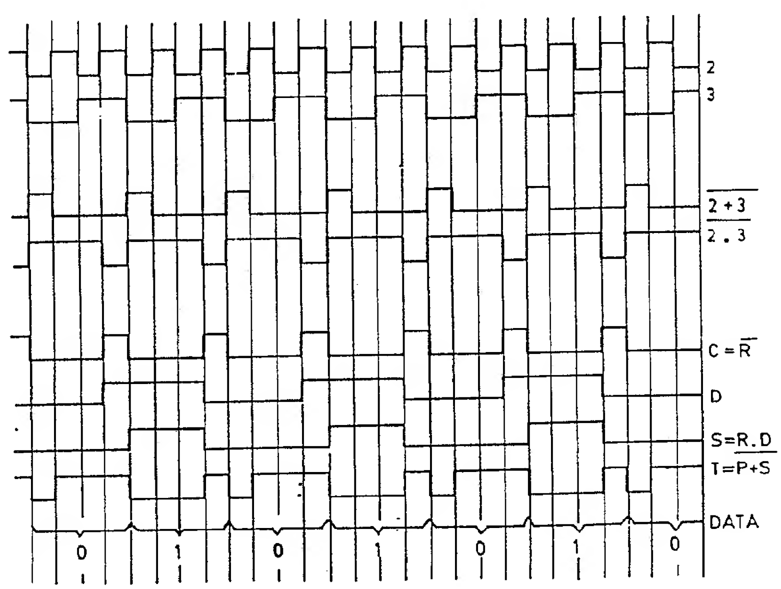
Skolnik M. Radar Handbook MGH 1970 pages 38-11 to 38-30
Skolnik M. Introduction to Radar Systems 1st edition MGH 1962 pages 594-601

(58) Field of search
H4L
Selected US specifications from IPC sub-classes G01S G08G

(54) Transponder

(57) A transponder which is mounted on a rail truck and which draws energy from an interrogating signal and transmits a unique signal when the interrogating signal is above a predetermined energy level. The unique signal is based on a code stored in a programmable memory and is transmitted as 64 data bits which inter alia identify the owner of the truck, and the number of the truck. A binary zero bit is represented by a "low" for the first 25% of the bit length followed by a "high" for the last 75%; a binary one by "low" for the first 75% and a "high" for the last 25%. The response is repeated whilst the interrogation signal exceeds a threshold or for a predetermined time.

FIG. 5



The drawing(s) originally filed was (were) informal and the print here reproduced is taken from a later filed formal copy.

GB 2 208 058 A

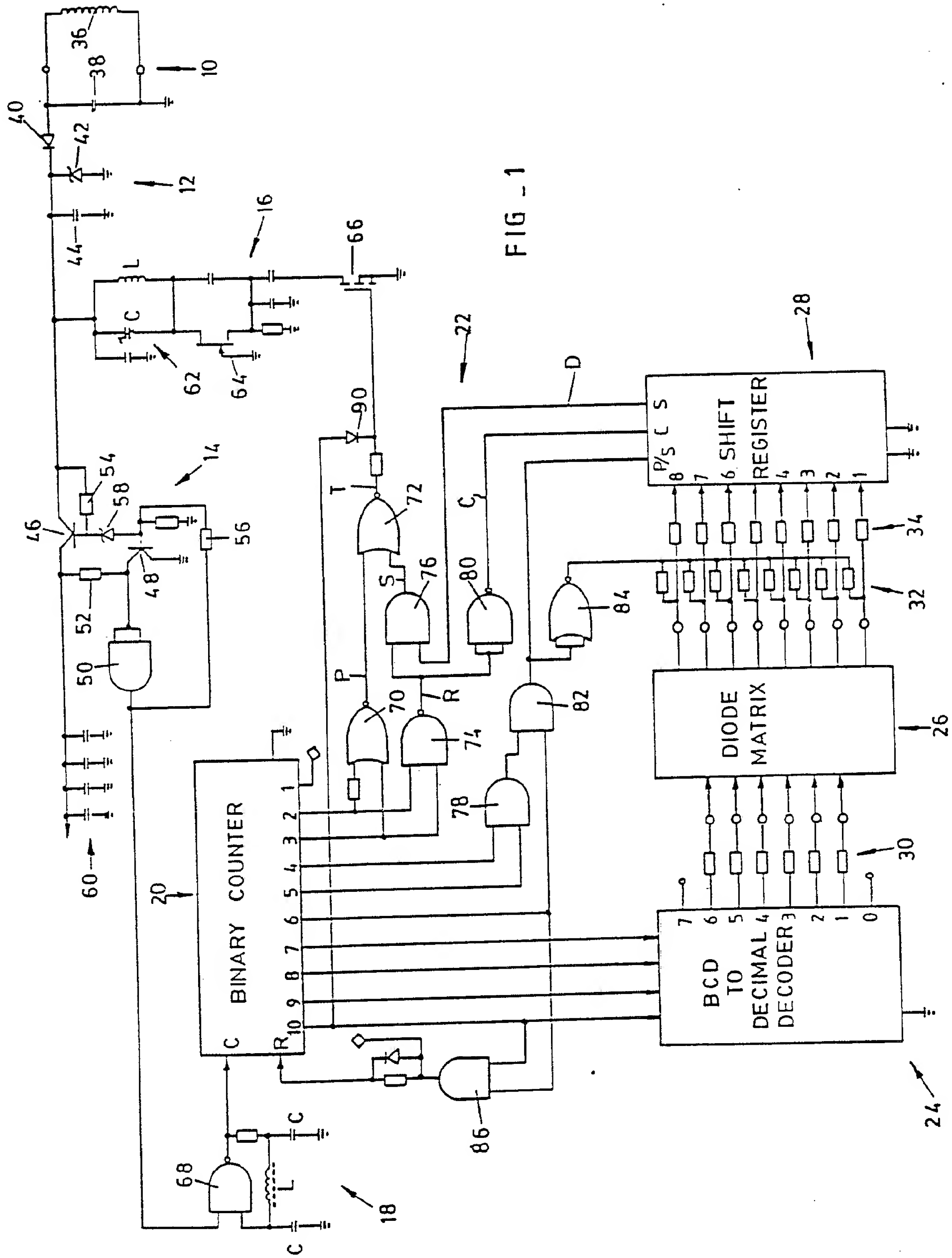

BINARY COUNTER
DIODE MATRIX
SHIFT REGISTER
BCD TO DECIMAL DECODER

FIG _1

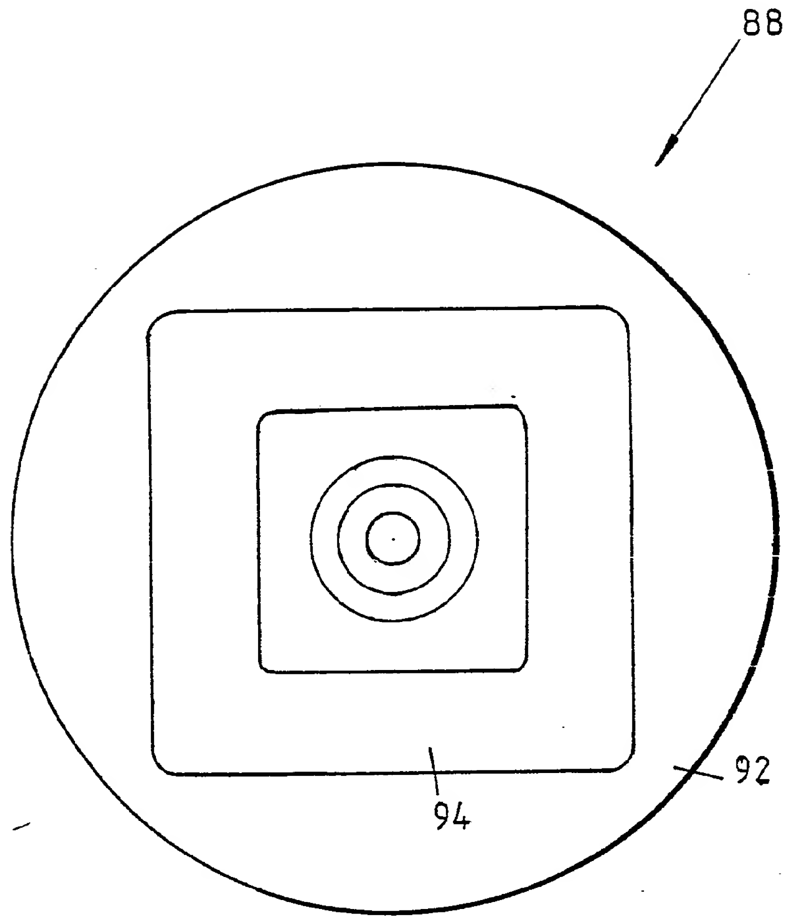


FIG _ 2

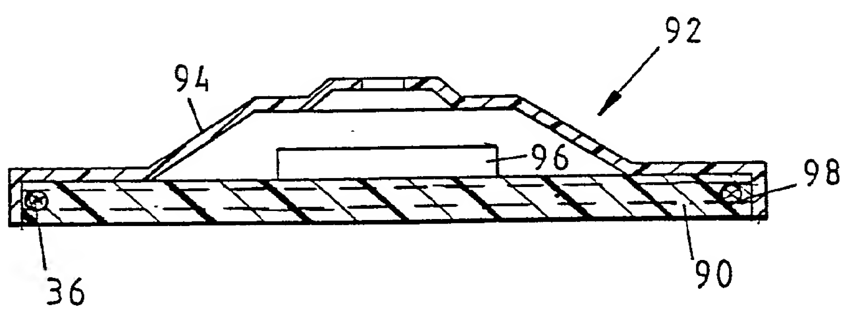


FIG _ 3

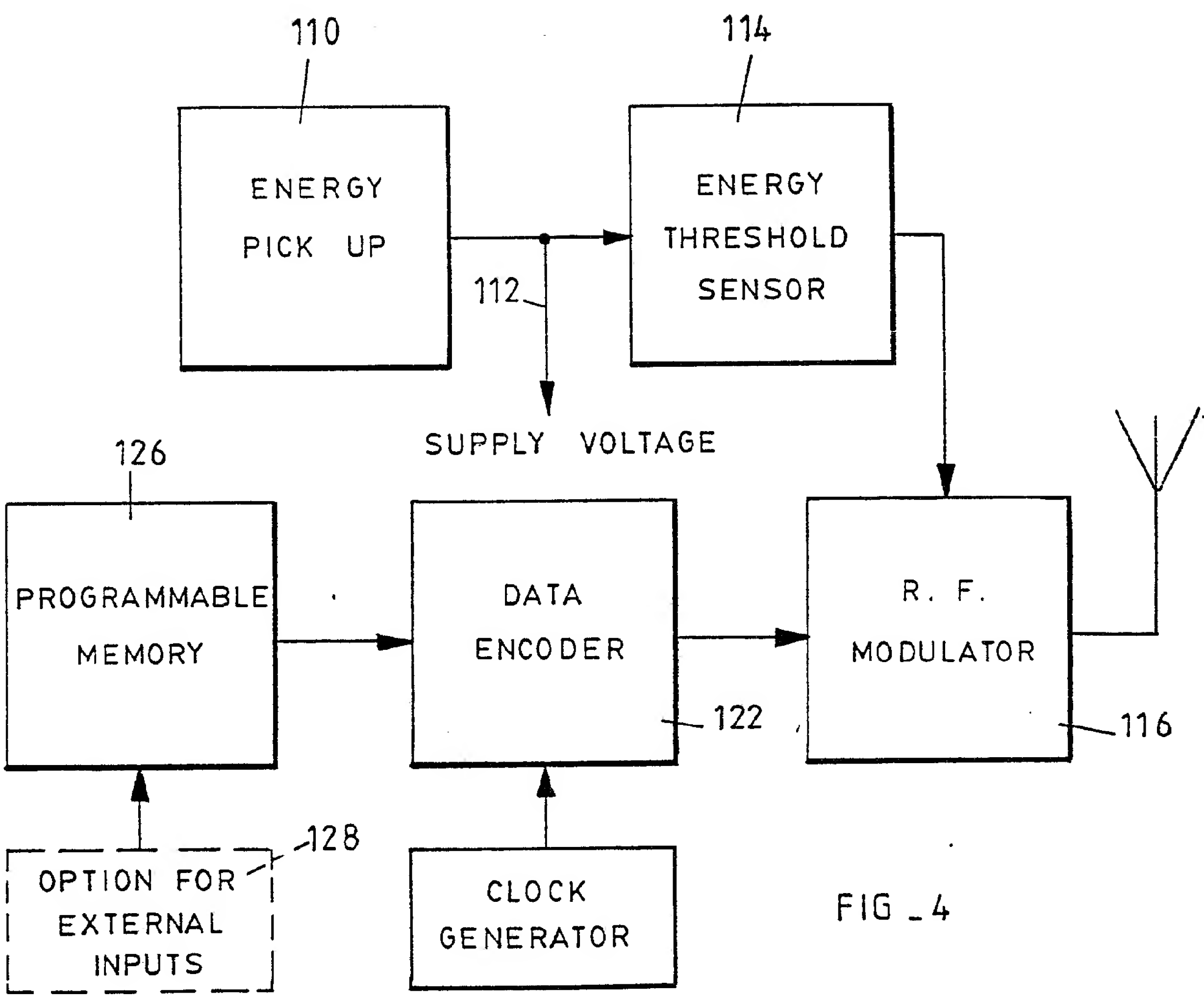

110
114
ENERGY
PICK UP
112
ENERGY
THRESHOLD
SENSOR
SUPPLY VOLTAGE
126
PROGRAMMABLE
MEMORY
DATA
ENCODER
122
R. F.
MODULATOR
116
128
OPTION FOR
EXTERNAL
INPUTS
CLOCK
GENERATOR

FIG _4

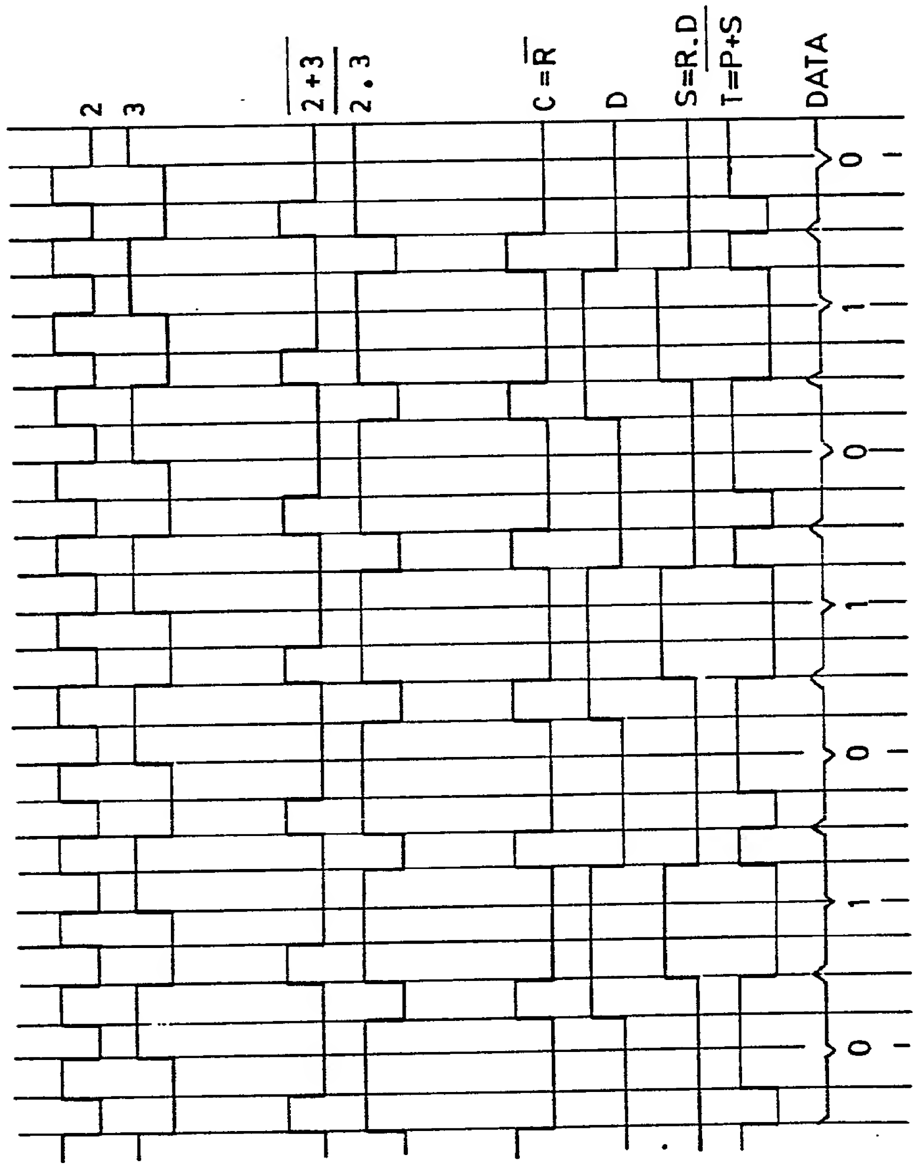

2
3
$\overline{2+3}$
$\overline{2.3}$
$C=\overline{R}$
D
$S=\overline{R.D}$
$T=P+S$
DATA
0
1
0
1
0
1
0

FIG_5

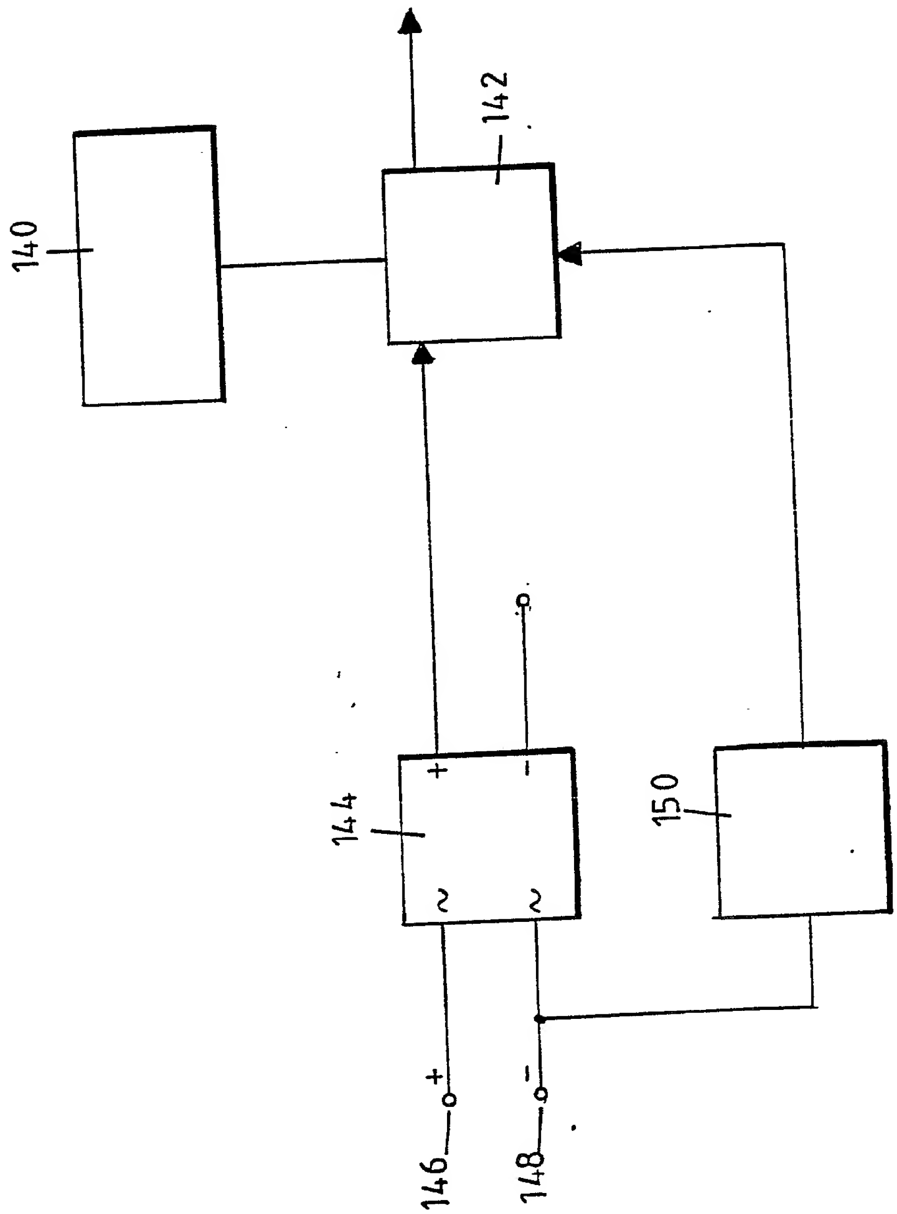


FIG - 6

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"TRANSPONDER"

This invention relates to a transponder.

A transponder which is used for vehicle identification, for example to identify the individual trucks on a train, should be passive i.e. it should not have an "in circuit" power supply, and it should be able to operate under a wide range of physical and electrical conditions. It should be capable of transmitting its identifying message repetitively, and at a high rate, while the transponder is within an active region of a detector.

A transponder of this kind is installed under field conditions. It may also happen that a transponder must be transferred from one truck or vehicle to another. Thus it is highly desirable for the transponder to be field programmable i.e. the unique signal which is transmitted by the transponder must be capable of being varied to suit the particular requirement at the time. One approach to this problem, known to the applicant, is disclosed in the specification of U.S.A. patent No. 4270187.

The invention provides a transponder which includes :
(a) detection means for detecting an interrogating signal,
(b) generating means,
(c) energy means which is responsive to the detection means and which derives energy from the detected interrogating signal,
(d) sensing means which is responsive to the detected interrogating signal and which enables the signal generating means when the energy of the detected interrogating signal exceeds a threshold level,
(e) the generating means being powered by energy drawn from the energy means and, when enabled, generating a unique signal to identify the transponder, and
(f) transmitting means which is powered by energy drawn from the energy means and which transmits the unique signal.

A timer may be used to control the period for which the unique signal is transmitted. Alternatively the unique signal is transmitted continuously, or intermittently, while the threshold level is exceeded.

The transmitting means may produce a carrier signal and the transponder may include means for modulating the carrier signal with the unique signal. The nature of modulation may vary from case to case but preferably frequency modulation is employed for example frequency shift keying.

The unique signal may be derived in any suitable way and preferably is based on a code stored in a programmable memory. Any suitable type of memory may be employed for this purpose for example a PROM, an EPROM, an EEPROM, a diode matrix, or the like. The memory is preferably arranged so that the code can be transferred to it i.e. so that it can be programmed, under field conditions.

The transponder may include logic means for causing the unique signal to be repeatedly generated.

The detection means may include a receiving coil and the electronic circuitry of the transponder may be mounted inside the boundaries of the coil. Preferably the circuitry is mounted on a disc which acts as a former for the coil. The periphery of the disc may include a groove or channel and the coil may be wound therein. A cover may be located on the disc and the interface between the components may be sealed in any suitable manner for example by use of an adhesive, ultrasonic welding or the like to ensure that the electronic circuitry and the coil are encased in a weatherproof housing.

The disc on which the circuitry is mounted may include a window or aperture which provides access to the storage means for the programming thereof.

The invention also provides a method of identifying an object which

includes the steps of transmitting an interrogating signal, detecting the interrogating signal by means associated with the object, generating a unique signal to identify the object, and transmitting the unique signal for the duration of a time interval in which the interrogating signal is detected. The unique signal may be transmitted repeatedly. Alternatively the unique signal may be transmitted for a predetermined period which is controlled by a timer.

The unique signal may be transmitted only while the energy of the detected interrogating signal exceeds a threshold level.

The method may include the step of using energy derived from the detected interrogating signal to generate and to transmit the unique signal.

Preferably the unique signal is generated as a pulse width modulated signal which is used to frequency modulate a carrier signal. The nature of the frequency modulation may be frequency shift keying.

The method of the invention, and the transponder, can be used in a variety of applications. However they lend themselves particularly to the identification of rail trucks or cars in a train of such vehicles. In this application the interrogating signal is transmitted from a stationary location which the train passes and the unique signal is transmitted by means of a transponder on one of the vehicles in the train. If the unique signal identifies the vehicle and if each vehicle has a distinct signal then the invention permits each vehicle in a train to be positively identified.

The principles of the invention can however be used in the reverse mode wherein a moving vehicle transmits the interrogating signal and when a stationary marker i.e. the transponder detects the interrogating signal a unique signal is transmitted which identifies the marker and thus acts as an electronic signpost.

The invention is further described by way of example with reference to the accompanying drawings in which :

Figure 1 is a diagram of a circuit used in a transponder according to the invention,

Figures 2 and 3 illustrate in plan and elevation respectively the appearance of a transponder according to the invention,

Figure 4 is a block diagram of the transponder circuit,

Figure 5 is a timing diagram of logic circuitry of the transponder, and

Figure 6 illustrates a variation of the invention.

Figure 1 illustrates the circuit of a transponder according to one form of the invention.

The circuit includes a detection section 10, a rectifier section 12, a regulator and threshold sensor 14, a transmission circuit 16, an oscillator 18, a binary counter 20, a logic circuit 22, a binary coded decimal to decimal decoder 24, a diode matrix 26, a shift register 28, a series of resistors collectively designated 30 connecting the outputs of the decoder 24 to the column inputs of the matrix 26, a series of resistors 32 connecting the logic circuit 22 to the row outputs of the diode matrix, and a third series of resistors 34 which connects the row outputs of the matrix 26 to the inputs of the shift register 28.

The detector circuit 10 includes a coil 36 and a capacitor 38 which have a resonant frequency equal to that of an interrogating signal.

The section 12 includes a rectifying diode 40, a voltage clamping zener

diode 42 and a smoothing capacitor 44.

The circuit 14 includes a series regulator transistor 46, a second transistor 48, a NAND gate 50, resistors 52, 54 and 56 and a zener diode 58. The stabilized output of this circuit is supplied to a bank of capacitors 60.

Energy from the capacitors 60 is used to power the circuit of the transponder.

The transmitter circuit 16 includes a resonant LC circuit 62 with a field effect transistor 64 as the active element. The circuit is modulated via an enhancement mode FET switch 66 which in turn is controlled by an output from the logic circuit 22.

The oscillator 18 includes a NAND gate 68 functioning as inverting amplifier and connected across an LC oscillator of pi configuration.

The binary counter 20, in this example of the invention, is a twelve stage binary counter with output terminals 1 to 10 as indicated.

The logic circuit includes AND, NAND and NOR gates 70 to 86 identified and connected as indicated.

The diode matrix 26 is a fusable link diode matrix which, in accordance with the invention, is physically arranged in such a way that it can be programmed under field conditions. It has six columns which are addressed through the resistors 30 by the outputs 1 to 6 of the decoder 24. The outputs 0 and 7 are not used.

The resistors 32 are pull up/pull down resistors on the row outputs of the diode matrix 26.

The series of resistors 30 and 34 are used to protect the outputs of the decoder 24 and the inputs of tbe shift resistor 28 during programming of the diode matrix 26.

The shift register 28 is eight bit static shift resistor. It has a clock terminal marked C and a parallel/serial input P/S. It also has a serial data output terminal S.

The shift register 28 has parallel data input terminals 1 to 8 connected via the resistors 34 to the diode matrix 26.

Figures 2 and 3 illustrate the physical construction of a housing 88 of the transponder of the invention. The transponder includes a disc base 90 shown in dotted outline in Figure 3 and a cover 92. The cover has a pyramidal recess 94 which forms a compartment for the electronics of the transponder designated 96 in Figure 3.

The periphery of the disc 90 has a channel 98 and the coil 36 of the detector circuit 10 shown in Figure 1 is wound in this periphery.

The components 90 and 92 are formed from suitable plastics material and are ultrasonically welded to each other with the transponder circuitry in position to form a weathertight durable housing 88 for the transponder.

Figure 4 illustrates in block diagram form the circuit of Figure 1, and its principle of operation. Energy is extracted from a detected signal by means of a unit 110 (corresponding to the sections 10 and 12 of Figure 1), and compared to a reference level by a sensor 114 (corresponding to the sensor 14).

Energy is supplied to the remainder of the circuit via a lead 112 when the detected energy is above a threshold level.

A unique code stored in a programmable memory 126 (corresponding to the diode matrix 26) is encoded in a unit 122 (corresponding to the logic circuit 22) and used to modulate a signal which is transmitted continuously, provided the detected energy is above the threshold level, by means of a device 116 (corresponding to the transmission circuit 16).

The transponder of the invention, in this example, is intended to be attached to a moving vehicle such as a truck or car in a train. Referring again to Figure 1 the diode matrix 26 is encoded in a unique manner which is identified with the particular truck. Other trucks in the train can carry similar transponders each encoded in their own particular manner. At some point on its journey the train is subjected to an interrogating signal transmitted from a stationary source preferably located between the tracks on which the train travels. This interrogating signal has a frequency which, as already mentioned, is substantially equal to the resonant frequency of the detector circuit 10. Thus as the transponder is electromagnetically linked to the interrogating signal the detector circuit 10 generates a signal which inter alia is dependent on the proximity of the coil 36 to the interrogating transmitter. This signal is rectified by the diode 40 and clamped to a maximum voltage by the zener diode 42. The voltage from the rectifier section 12 is applied to the circuit 14. When this voltage exceeds the conducting voltage of the zener diode 58 it conducts via the resistor 54 and the transistor 48 is turned on. The collector of the transistor goes low and the output of the NAND gate 50 goes from a low level, at which it is held by the resistor 52, to a high level. Positive feedback is applied to the base of the transistor 48 via the resistor 56 to ensure clean switching action of the transistor.

The high level signal output by the circuit 14 is applied to the oscillator 18. As indicated this takes place only when the turn on voltage of the threshold sensor included in the circuit 14 is exceeded. The LC circuit is resonated with positive feedback being applied via the gate 68 to sustain resonant frequency oscillation.

The binary counter 20, as is hereinafter described, controls the generation of a unique signal for identifying the particular transponder. As the oscillator 18 is only enabled when a threshold voltage is exceeded the situation is avoided in which the identification signal gradually rises out of background noise. The possibility that synchronous noise could cause a false message to be accepted by a receiver is therefore minimized.

The oscillator 18 clocks the binary counter 20.

The clocked outputs 7 to 10 of the binary counter 20 are applied to the decoder 24, converted to decimal form, and connected to the diode matrix via output terminals 1 to 6. The data output on the rows of the diode matrix depends on the coding of the matrix. This data is presented on the parallel inputs 1 to 8 of the shift register 28 and is clocked in with the application of clock pulses output by the NAND gate 80, to the shift register.

The data to be transmitted is clocked serially out of the shift register and encoded by the logic circuit components 70 to 76. The signal output by the NOR gate 72 is used to switch the transistor 66.

When a signal is detected by the circuit 10 the LC circuit of the transmitter 16 is supplied with energy and oscillates. While the transistor 66 is not switched the circuit 16 transmits a fixed frequency signal. When the transistor 66 is switched the free running frequency of the oscillator is changed by frequency shift keying (FSK) modulation. A logical one output by the NOR gate 72 reduces the oscillating frequency of the circuit 16 and a logical 0 increases the resonant frequency.

The signal transmitted by the transponder includes twelve programmable digits. Each digit or character has four bits of data and each data bit is encoded as a pulse width modulated data bit. The 48 programmable bits are stored in the matrix 26 which is configured in an 8 row by 6 column format.

The coding is done by fusing links in series with selected diodes in the marix. In the uncoded state the matrix contains 48 binary ones. A programmed diode link thus represents a binary zero.

The columns of the diode matrix are addresed sequentially by the decoder 24 and as each column is addressed the 8 row diodes associated with that column are addressed with their outputs going to the shift register 28.

As the outputs 0 and 7 of the decoder 24 are not used there is a total of 48 bits transferred in one cycle to the shift register. When the output 7 of the decoder 24 goes high, as it is not connected to the matrix 26, the shift register is loaded with zeros determined by the pull down resistors 32. Four of the zeros are clocked out of the shift register as an end of message sequence but a further four zeros will have entered the shift register. Thus at the beginning of the message the shift register will be loaded with zeros which will then be transmitted as the first 8 bits of the message. Similarly as the output 0 of the decoder 24 is not connected to the matrix the shift register is again loaded with zeros and these forms bits 9 to 16 in the transmitted message.

An understanding of the message structure used in the invention is necessary for an understanding of the operation of the transponder.

Each transponder message consists of 64 bits and adjacent messages are separated by markers which are each equivalent to 4 data bits.

Messages and markers are transmitted sequentially as long as the energy received by the transponder exceeds the threshold level. Alternatively transmission takes place for a predetermined period only, which is controlled by means of a timer.

Data is transmitted starting with the most significant bit (MSB) of the least significant digit (LSD), terminating with the least significant bit of the most significant digit.

The MSD (the last character to be transmitted) is always a longitudinal redundancy check (LRC) character, calculated on all the preceeding characters. i.e. the 15 preceeding characters.

As indicated hereinbefore the transponder has 12 programmable characters and consequently 48 data bits may be programmed. (It is to be understood though that 64 data bits may be programmed, if desired, with suitable circuitry). The other four characters (16 data bits), which are the four most least significant digits, are transmitted as zero's.

For the identification of vehicles such as rail trucks the following data format, starting from the MSD, is suitable:

LRC - 1 character
Truck code - 8 characters
Owner code - 1 character
Axle number - 1 character
Spares - 5 characters (all zero's)

Each character comprises four bits of data, and hence is a hexidecimal character in the range 0 to F inclusive.

Each data bit is encoded as a pulse width modulated data bit as shown in Figure 4 in accordance with the following specification:

(a) the start of each data bit is represented by a negative going transition,

(b) a binary zero is represented by a positive going transition 25% of the way through the time period of a bit, and

(c) a binary one is represented by a positive going transition 75% of the way through the time period of a bit.

This form of encoding provides easy regeneration of the clock signal. A negative going edge always represents the start of a bit period.

No additional synchronising of the decoding circuitry is required.

The high effective clock rate, which is twice the data rate, requires the transmitted signal to have a wide band width. However, the technique has been proven in the field. It is tolerant to variations in the master clock frequency and in theory up to 25% variation in clock frequency can be tolerated.

After 64 bits of data have been transmitted the output 10 of the counter 20 goes high and this, through a diode 90, holds the transistor 66 in the on state regardless of data from the logic circuitry 22. Thus the transmitted signal is held at a fixed frequency. The receiver circuitry can therefore identify the transmitted signal as an end of message marker. After a time period equal to 4 data bits the output 6 of the counter 20 goes high and through the AND gate 86 a reset pulse is applied to the counter 20. The message sequence thus recommences.

In the apparatus of the invention energy is extracted from a detected interrogating signal and used to power the circuitry of the transponder so that it can transmit a unique identifying signal. The logic circuitry of the transponder is enabled only when the detected energy exceeds a threshold level. While this threshold level is exceeded the unique signal is repeatedly generated under the control of the counter 20 and transmitted. It is also possible, as previously pointed out, to transmit the the signal only for a predetermined period which is controlled by means of a timer included, for example, in the circuit 16, or the threshold sensor 14. The unique signal is internally generated in pulse width modulated form and is used to frequency modulate the carrier signal of the transmitter circuit 16.

The unique signal is determined by the coding of the diode matrix 26. This matrix has pins which enable it to be coded and these are located in a window formed in the base 90 of the housing 88 of the transponder. After the matrix has been coded the window is closed so that the coding of the matrix cannot be interfered with.

The invention thus provides a passive transponder i.e. one which does and have a separate power source, which is programmable under field conditions and which can generate a selected one of a large number of unique codes. As the unique signal is transmitted only when the interrogating signal is of a relatively high energy level spurious signals due to random noise effects are obviated. The physical construction of the transponder is compact, robust and weatherproof due to the encasing nature of the cover and base for the coil 36 and the

circuitry 96.

Figure 4 illustrates, in general manner, a programmable memory 126 which, in the Figure 1 embodiment, is constituted by the diode matrix 26. Figure 4 indicates that external inputs 128 to the memory may be employed for programming the memory. For example, referring to Figure 6, the diode matrix may be replaced by an electrically erasable programmable read-only memory 140 (EEPROM). It is also possible to utilise a static read-only memory (ROM) with a standby battery.

Figure 6 also illustrates a voltage regulator 142, a bridge rectifier 144 with input terminals 146 and 148, and an analogue level detector 150 which in this example is a Texas Instrument's device, part number TL489.

In the programming of an EEPROM a number of conditions have to be met to ensure the effective entry of a data bit. The appropriate memory location must be addressed, reset, and programmed. This is achieved by momentarily driving the power supply high to a value above the normal voltage for the circuit. The data bit is "burnt in" in this manner and remains non-volatile until such a time as the procedure is repeated.

In the circuit shown in Figure 6 it is apparent that with power supplied to the bridge rectifier as shown, the voltage to the level detector 150 is of the order of 0,6 volts i.e. the voltdrop over a diode. However if the supply leads are reversed then the correct positive voltage is supplied to the input of the voltage regulator 142 by normal bridge rectifier action. The negative input to the regulator is however now positive to the extent of the input voltage and so is the negative busbar.

Thus in accordance with the invention a bridge rectifier is configured in such a way across the power supply input so as to allow programming to take place only when the polarity at the input terminals 146 and 148 is reversed. The memory 140 is therefore only programmable when the right sequence of conditions is met according to the EEPROM's timing diagram simultaneously with the reversal of the power supply. In this way a high

degree of security is achieved.

Under the conditions described the supply voltage is modulated to five different levels. These levels are decoded by the detector 150 which successively selects an output as the analogue input voltage exceeds internal preset values. Four of these outputs condition the EEPROM as regards data status, clock, preset enable and supply voltage control. The fifth output inhibits the other transmitter circuits from functioning during the programming sequence.

The programming voltage rise is enabled as the output of the detector 150 is used to address the control voltage of the programmable voltage regulator 142. In this way specific input voltage levels on the power supply leads cause the appropriate function to be programmed on the EEPROM.

In order to prevent inadvertent programming of the EEPROM the circuit is arranged such that the programming voltage to the EEPROM, prior to the input regulator, must exceed 40 volts.

It follows that the EEPROM can be programmed via the supply leads or via leads which are accessible in any other way. As the transponder of the invention is a passive device the arrangement shown in Figure 6 is used merely for programming of the EEPROM and not for powering the transponder. Referring to Figures 2 and 3 the terminals 146 and 148 could be formed respectively by means of a mounting bolt which is used for fixing the housing 88 to a vehicle, and a pin or lug which is moulded into the plastic housing and which is also accessible from outside the housing.

It is also possible, and it falls within the scope of the invention, to program the EEPROM remotely by means of inductive coupling. In this case the power leads are substituted by an inductive coupling to the outer peripheral coil 36, or to some other coil, to achieve the same result. In this instance the bridge rectifier circuit could not be used as the input voltages are AC. Some other means of protection, for example tone coding,

would however be used. The tones are used in place of the voltage levels to program the memory.

CLAIMS:-

1. A method of identifying an object which includes the steps of transmitting an interrogating signal, detecting the interrogating signal by means associated with the object, generating a unique signal to identify the object, and transmitting the unique signal for the duration of a time interval in which the interrogating signal is detected.

2. A method according to claim 11 which includes the step of transmitting the unique signal only while the energy of the detected interrogating signal exceeds a threshold level.

3. A method according to claim 11 or 12 which includes the step of using energy derived from the detected interrogating signal to generate and to transmit the unique signal.

4. A method according to any one of claims 11 to 13 wherein the unique signal comprises a plurality of data bits, the start of each data bit being represented by a negative going transition, a binary zero being represented by a positive going transition 25% of the way through the time period of a bit, and a binary one being represented by a positive going transition 75% of the way through the time period of a bit.

5. A method according to claim 14 wherein the unique signal comprises 64 data bits, at least 32 bits being used to identify the object, and at least 4 bits being used to identify the owner of the object.

6. A method according to any one of claims 11 to 15 wherein the object is a truck in a train of trucks, and the interrogating signal is transmitted from a stationary location which the train passes and the unique signal is transmitted by means of a transponder on the truck.

7. A method according to any one of claims 11 to 16 wherein the unique signal is transmitted repeatedly.

8. A method according to any one of claims 11 to 17 wherein the unique signal is transmitted for a predetermined period.

9. A method of identifying an object substantially as hereinbefore described with reference to any one of the accompanying drawings.

10 A transponder which includes:

(a) detection means for detecting an interrogating signal,

(b) generating means,

(c) energy means which is responsive to the detection means and which derives energy from the detected interrogating signal,

(d) sensing means which is responsive to the detected interrogating signal and which enables the signal generating means when the energy of the detected interrogating signal exceeds a threshold level,

(e) the generating means being powered by energy drawn from the energy means and, when encoded, generating a unique signal to identify the transponder, and

(f) transmitting means which is powered by energy drawn from the energy means and which transmits the unique signal.

11. A transponder according to claim 1 in which the transmitting means produces a carrier signal and which includes means for modulating the carrier signal with the unique signal.

12. A transponder according to claim 2 in which the modulation is frequency shift keying.

13. A transponder according to any one of claims 1 to 3 which includes a programmable memory, the unique signal being derived from a code stored in the memory.

14. A transponder according to claim 4 in which the programmable memory is a diode matrix.

15. A transponder according to claim 4 in which the programmable memory is an electrically erasable programmable read-only memory (EEPROM).

16. A transponder according to claim 6 which includes a programmable voltage regulator connected to the EEPROM, and a level detector for

programming the voltage regulator in response to an analogue signal applied to the level detector.

17. A transponder according to any one of claims 1 to 7 which includes logic means for causing the unique signal to be repeatedly generated.

18. A transponder according to any one of claims 1 to 8 which includes timer means for controlling the period for which the unique signal is transmitted.

19. A transponder according to any one of claims 1 to 9 wherein the detection means includes a coil and which is mounted on a disc which acts as a former for the coil.

20. A transponder substantially as hereinbefore described with reference to any one of the accompanying drawings.

Amendments to the claims have been filed as follows

CLAIMS

1. A method of identifying an object which includes the steps of:

a) transmitting an interrogating signal,

b) detecting the interrogating signal by means associated with the object,

c) generating a unique signal to identify the object, the unique signal comprising a plurality of data bits, the start of each data bit being represented by a negative going transition, a binary zero being represented by a positive going transition 25% of the way through the time period of a bit, and a binary one being represented by a positive going transition 75% of the way through the time period of a bit, and

d) transmitting the unique signal for the duration of a time interval in which the interrogating signal is detected, wherein the unique signal comprises 64 data bits, at least 32 bits being used to identify the object, and at least 4 bits being used to identify the owner of the object.

2. A method according to claim 1 in which includes the step of transmitting the unique signal only while the energy of the detected interrogating signal exceeds a threshold level.

3. A method according to claim 1 or 2 which includes the step of using energy derived from the detected interrogating signal to generate and to transmit the unique signal.

4. A method according to claim 1, 2 or 3 wherein the unique signal comprises 64 data bits, at least 32 bits being used to identify the object, and at least 4 bits being used to identify the owner of the object.

5. A method according to any one of claims 1 to 4 wherein the object is a truck in a train of trucks, and the interrogating signal is transmitted from a stationary location which the train passes and the unique signal is transmitted by means of a transponder on the truck.

6. A method according to any one of claims 1 to 5 wherein the unique signal is transmitted repeatedly.

7. A method according to any one of claims 1 to 6 wherein the unique signal is transmitted for a predetermined period.

8. A method of identifying an object substantially as hereinbefore described with reference to any one of the accompanying drawings.

9. Apparatus for identifying an object which includes:

a) means for transmitting an interrogating signal,

b) means for detecting the interrogating signal by means associated with the object,

c) means for generating a unique signal to identify the object, the unique signal comprising 64 data bits, at least 32 bits being used to identify the object, and at least 4 bits being used to identify the owner of the

object, the start of each data bit being represented by a negative going transition, a binary zero being represented by a positive going transition 25% of the way through the time period of a bit, and a binary one being represented by a positive going transition 75% of the way through the time period of a bit, and

d) means for transmitting the unique signal for the duration of a time interval in which the interrogating signal is detected.

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